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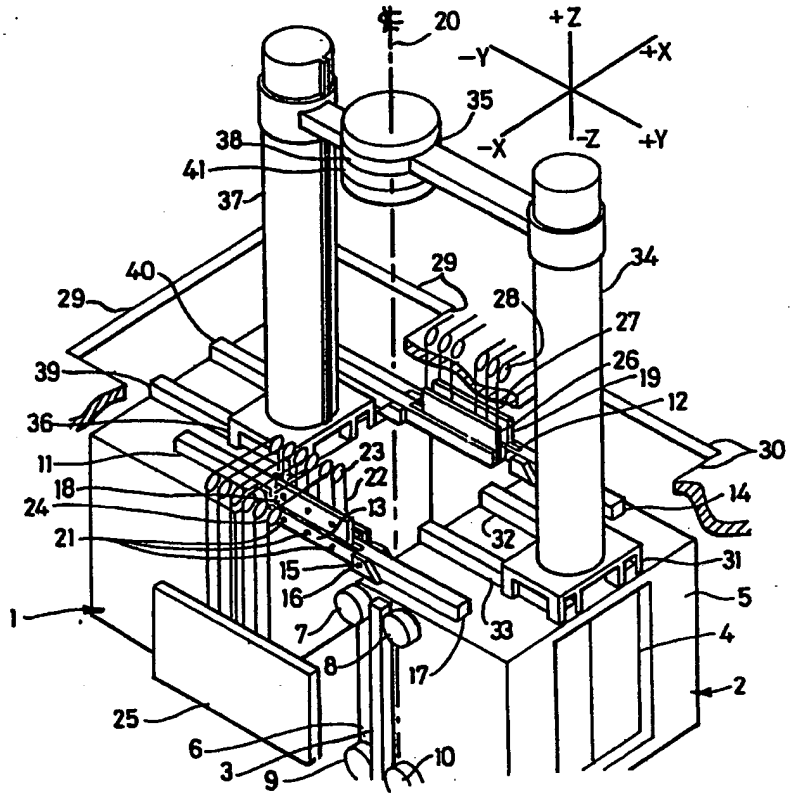
(54) Title: IMPROVEMENTS TO LIFTS

(57) Abstract

A passenger lift system which optimises the use of space in tall buildings by providing a number of lift cars and two lift shafts. One shaft is dedicated to upwards travel and the other to downwards travel, cars are transferred from shaft to shaft at the top and bottom. Each car is independently wound and moves to respond to: a) a call from a landing; b) a destination demanded from witin the car; c) to move away ahead of another car. Car doors and landing doors are used as in a conventional lift system.



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Title: Improvements to Lifts

Field of the invention

This invention concerns lift systems particularly for use in tall buildings.

Background to the Invention

Because of the high cost of land in city centres it is commercially attractive to construct very tall buildings, to maximise the available floor space in the building on a given area of land. In a tall building it is necessary to provide a vertical transport system to enable occupants to travel between the floor of the building which they occupy and the entrance/exit floor of the building (usually the ground level). The most practical system known is a number of lifts. It is common experience to have to wait longer than desirable to be able to enter a lift. The quality of the lift service is limited by cost; in a building with a moderate number of floors the limiting factor is the cost of the lift installation itself. In a very tall building the limitation is not in the cost of the lift installation but in the fraction of the total building volume occupied by the lift system which it thus not available for occupation and therefore yields no income. In the present state of the art this limits the economic height of buildings to about one hundred floors. Even this height is only served efficiently by some recent developments in lift systems, such as the double-deck lift car and the sky lobby.

The present invention aims to provide an efficient lift service in a tall building whilst occupying only a minimum volume within the building and making the maximum use of

existing lift technology, especially of those features of existing technology which relate to safety.

Summary of the Invention

According to this invention a vertical path is provided in which lift cars normally travel only upwards and an associated vertical path is provided in which lift cars normally travel only downwards; means being provided to transfer a car from the upper part of the up path to the upper part of the down path, and further means being provided to transfer a car from the lower part of the down path to the lower part of the up path. Propulsion means are provided to enable any car to rise or fall independently of any other car. Control means are provided to prevent a car suffering a damaging impact and to rise or fall responsively to signals originating from landings, from cars or from an overall control system serving at least all the cars in a pair of shafts.

According to another aspect of this invention each car is provided with at least one moveable bracket which, in its operational position can be engaged directly or indirectly with ropes or chains and which, when not engaged with ropes or chains can be positioned to permit passage of the car from one path to the other without interfering with the ropes or chains.

According to another aspect of this invention means are provided to fix the ropes or chains to a static structure whilst those brackets are disengaged.

According to another aspect of this invention the same set of ropes or chains are engaged by brackets on a car

whichever path is occupied by that car.

According to another aspect of the invention the transfer of a car from one path to another is effected by a vertical translation, a rotation about a vertical axis and a second vertical translation in the opposite direction to the first vertical translation.

According to another aspect of this invention a car is equipped with two sets of moveable brackets and has the same orientation whichever path it occupies.

According to another aspect of this invention means are provided to transfer a car to a position external to the volume swept by a car in normal operation.

According to another aspect of this invention means are provided to permit one car to support another car in the same path and for the two cars together to be caused to rise or fall using only the propulsion means normally dedicated to one of the cars.

According to another aspect of the invention the propulsion means of a car may be by the rotation of at least one wheel, which is attached to the car, engaging a fixed vertical member in a path.

According to another aspect of this invention the engagement of a propulsion wheel with a fixed vertical member may be by friction with the addition of gear teeth on a wheel able to mesh with rack teeth on a vertical member but in which the flanks of the gear teeth normally support little, if any, of the weight of the cars.

Detailed Description

The invention will now be described, by way of example only, with reference to the accompanying drawings.

Figure I shows the main features of the invention with some details omitted for clarity. Reference numeral 1 denotes generally a car situated at the top of the "down" service path,and 2 is a car situated at the top of the "up" service path. (The word "path" is used to denote the space through which a car can move, not any specific item of hardware. And the phrase "service path" that part of the path in which the car may carry passengers, but not for example those parts of the path traversed whilst transferring from down path to up path or vice versa).

In each path are at least two guide rails. A portion of a guide rail is shown at 3; the precise form of the cross-section of the rail is not part of this invention but, for example, it may be a rectangle as illustrated, fixed to the building structure by bolting through drilled and counterbored holes: or a T-section as specified in British Standard 5655 Part 9, 1985 may be used. A minimum of two rails is required in each path and may be conveniently arranged at the right and left sides of the car. (We define that face 5 of the car in which the doors 4 are situated as the front and that face 6 adjacent to rail 3 as the left hand side).

The figure shows rail 3 engaged by four wheels 7, 8, 9 and 10. A similar set of wheels on the right hand side of the car may engage a similar rail. It can be economical of space to employ a third rail in each path, situated

adjacent to either the front or back of the car and a set of four wheels on the car engaging that third rail.

Each car is fitted with two moveable brackets. Car 1 has brackets 11 and 12, and car 2 has brackets 13 and 14. Each bracket is able to rotate through 90° about an axis parallel to the X axis. Bracket 13 pivots about pin 15 in support trunnion 16 from the position as shown to the vertical with end 17 uppermost. Bracket 13 is securely pinned to cable plate 18 and bracket 14 to cable plate 19. Brackets 13 and 14 are equi-spaced about a YZ plane through centre line 20. The fixing points 21 which unite bracket 13 to cable plate 18 are symmetrical about an XZ plane through centre line 20 and are identical to corresponding fixing points (not shown) which unit bracket 14 to cable plate 19. A set of twelve ropes are used to raise and lower car 2. Six of these ropes are attached to cable plate 18. (One of the ropes is denoted 22). Each of these six ropes passes over two pulleys (rope 22 passes over pulleys 23,24). Each of the ropes also engages a traction drive as is well known in the art, and is therefore not shown in the figure. Each rope extends over the second pulley (such as 24) and is attached to 25 which is a counterweight fitted with tension equalisers. An exactly similar symmetrically placed set of ropes (not shown) are attached to cable plate 19 and engage pulleys (not shown), driving sheave (not shown) and counterweight (not shown). The figure shows the ropes, exampled by 22, broken. This is to indicate a great length of rope since, clearly, when a car is at the top of its service path, the counterweight is at the bottom of its service path.

Most of the mechanical detail of car 1 is identical to

that of car 2, but with one important difference. Brackets 11 and 12 are symmetrically placed about the YZ plane through centre line 20, but the separation of 11 and 12 is different from that of 13 and 14, so that when in different paths the cars may pass each other in the vertical direction without interference. The cable plate, ropes, pulleys and counterweight associated with bracket 11 have been omitted for clarity. However, the figure shows cable plate 26 engaged with bracket 12. This is attached to six ropes, exampled by 27 and each rope engages two pulleys and a driving sheave.

It is to be noted that the ropes (exampled by 27) associated with car 1 are at different distances from the XZ plane through centre line 20 than the ropes associated with car 2. This enables the horizontal parts of the ropes for each car to be in the same plane and thus permits easier and hence cheaper mounting of pulleys such as 23, 24 and 28 on the main support floor. (The main support floor is shown largely cut away in the figure to show the mechanism. Its position can be seen from the edges 29 and 30 of the apertures through which the cars pass in the transfer operation. It is to be understood that in addition to these apertures in the floor there are also small holes to pass the ropes).

In addition, as it is necessary for counterweights to pass each other, sets of pulleys such as 24 are arranged at different distances from the YZ plane through centre line 20 and the guide rails (not shown) for each counterweight are at corresponding distances from the said YZ plane. For economy, each path has only one set of guide rails, therefore preferably the guide wheels of one car are similar to those of any other car. Also, for economy a

car uses the same guide wheels in each path, therefore preferably the guide rails in one path are symmetrical about centre line 20 with the guide rails in the other path.

The means by which a car is transferred from the top of the up path to the top of the down path will now be described. The transfer cycle starts as a car, such as car 2, arrives at the top landing. The doors 4 open to let passengers leave the car and preferably an audible announcement is given to instruct passengers that they must leave the car. At the same time cable plates 18 and 19 are clamped in their correct positions to the main support floor. Grab 31 engages top ridges 32 and 33 of the car 2. The ridges are symmetrical about the YZ plane through centre line 20, and the ridges are similar to each other and to the corresponding ridges on each other car. Various methods of engaging grab 31 to ridges 32 and 33 are possible, for example pins may be placed into holes through both, or ridges 32, 33 may be T-section, with 31 having jaws which pass under the cross bar of the T-section. Ram 34 then takes the weight of car 2 thus relieving the load on cable plates 13 and 14. Only when that weight is proved to be relieved can the brackets 13 and 14 be disengaged from cable plates 18 and 19.

As an additional safety feature ram 34 may prove that the weight it is supporting is that of the car and does not include a passenger who has failed to leave the car. Brackets 13 and 14 pivot into a vertical position, ram 34 then raises grab 31 and car 2 high enough to clear the main support floor and cables. Slewing ring 35 then rotates to place car 2 above the down path. By this time grab 36 has relinquished its engagement to ridges 39 and

40 of car 1, either ram 37 has risen to clear the ridges or car 1 has travelled downwards and slewing ring 41 has moved 36 and 37 clear of the down path. Ram 34 now lowers grab 31 and car 2 to the level of the top landing (the position shown occupied by car 1 in the figure). By this time car 1 has started to descend and is clear of the top landing. Brackets 13 and 14 pivot into a horizontal position, and are locked to cable plates 19 and 18 respectively. The doors 4 open to receive passengers (if any), the winding sheave is torqued to take the weight of the car and relieve the weight on ram 34. Only when the load on ram 34 has been proved relieved can the grab 31 release ridges 32 and 33. Car 2 is then ready to descend as required.

From the above description of the top-to-top transfer mechanism, the construction of a suitable bottom-to-bottom transfer mechanism will be apparent. We have described the transfer mechanism as with two mechanisms each including a grab, ram and slewing ring. It will be understood that a system can be constructed with only one such transfer mechanism at the top (and one at the bottom) but two mechanisms permit operations to be carried out in parallel and thus reduce transfer times.

In addition to the normal functioning of the lift system certain additional features are desirable.

Service bay

For routine servicing or to cope with an unscheduled stoppage it must be possible to take a car and its associated gear out of service. This is conveniently arranged by bringing that car to the top or bottom of a

service path, starting the transfer operation, but stopping the rotation at some intermediate position, for example after having slewed through 90°. The car is then moved in the X direction (this motion need not be fast, silent or operable by the unskilled). All the other cars of the system may then operate normally whilst the car or its winding gear is attended to.

It may be convenient to provide one more car (with its gear) than is required for normal service. Cars and gear may then receive routine service attention on a rota basis without disturbing the normal operation.

In the event of a failure, it will be necessary to restore service promptly. This may be achieved easily, and by a person authorised to carry out this specific operation but who need not be a fully trained and authorised lift mechanic. When a car has failed, first move all the other cars but one into the other path. Clear the passenger from the failed car and the one car. The one car is then brought into contact with the failed car either above or below. If the one car is below the failed car a grab, similar to 31, on the failed car engages the ridges of the one car. The one car lifts the failed car to the top landing. The failed car is then moved into the service bay. The remainder of the system then resumes normal operation; and an authorised mechanic may be called to attend to the fault. This gives the great benefit that, apart from the very short time when the dead car is being moved to the service bay, it will not be apparent to passengers that there is any fault in the system, giving passengers the impression of very good reliability and service.

The passenger operated controls are similar to those of conventional lift systems, i.e. in each car is an array of push buttons on touch buttons. When a passenger enters a car he operates the button numbered for his destination floor, and the car proceeds to that floor. An additional automatic function slows or stops the car to prevent any impact with a slowed or stopped preceding car. A further automatic function causes an unoccupied car to move ahead to clear the way for the subsequent car if that subsequent car has a passenger and a destination ahead of the unoccupied car. A car will also move ahead to pick up passengers at a landing where the call button has been activated. There will be a noticeable difference from conventional lift systems in that the "up" and "down" call buttons will be separate, one by the "up" door and one by the "down" door. This will improve the flow of foot traffic.

If it is desired to have the "up" and "down" landing doors side by side this can be achieved by relatively small modifications to the arrangement described above. In this case each car has two sets of brackets, one set operating over each side of the car, rather than the back. The transfer mechanism could then consist of rams and grabs as described above, but each ram would then be moved horizontaly without rotation. The embodiments of the invention described above provide the advantages sought with maximum use of the existing technology with minimum requirements for development, by making the maximum use of the existing technology with only those innovations necessary to optimise the use of the space occupied by lift shafts. However, other embodiments are possible which could save even more space at the expense of further development.

Rack and pinion drive is used in some lift systems, but usually only for low speed systems primarily intended for goods rather than passengers. At higher speeds rack and pinion drives tend to be noisy. A friction drive by a smooth surfaced wheel of suitable construction can be acceptably quiet, but is unlikely to be acceptable because of doubts about safety. However, a friction drive for normal working, backed up by a rack and pinion which gives support immune to a possible failure of friction is acceptable from all points of view.

Figure II illustrates one of the possible techniques. Drive is applied to shaft 50 and friction wheel 51 is rigidly attached to shaft 50. Shaft 50 also drives one bevel gear 52 of a differential. The other elements of the differential are bevel wheel 53, a number of small bevel wheels of which two are shown as 54, 55 and bearing ring 56. Also attached is a slip limiter 57; this may be any of a number of well known devices such as a step up gear and a viscous damper, a centrifugal governor, or an active device which senses the existence of a torque load on bevel gear 53 and moves slowly to yield to that load. Alternatively a limited slip differential such as the ZF differential well known in the automotive art may be used. Thus a toothed wheel 58 connected to the bevel wheel 53 will carry a substantial load, giving positive support of the car only if friction wheel 51 is slipping to an extent which would be dangerous but for the existence of the differential and of toothed wheel 58.

CLAIMS

1. A lift system comprising a first vertical path in which lift cars normally travel only upwards; a second associated vertical path in which lift cars normally travel only downwards; first transfer means to transfer a car from the upper part of the up path to the upper part of the down path; second transfer means to transfer a car from the lower part of the down path to the lower part of the up path; propulsion means which enable any car to rise or fall independently of any other car; control means adapted to prevent a car suffering damaging impact with any other car and to rise or fall in response to signals originating from landings, or from other cars or from an overall control system serving all the cars in the pair of shafts.

2. A lift system as claimed in claim 1, wherein each car is provided with moveable arms which, in their operational position can engage ropes or chains and which can be disengaged and moved to a parked position clear of the ropes or chains to permit passage of the car from one path to the other without interfering with the ropes or chains.

3. A lift system as claimed in claim 2, in which the engagement of the arms with the ropes or chains is through the intermediary of a plate number itself separable from an arm to permit transfer of the car from one path to the other.

4. A lift system as claimed in claim 2 or 3, wherein means is provided to fix the ropes or chains to a static structure while they are disengaged from a car.

5. A lift system as claimed in any of claims 2 to 4 in which ropes or chains extend parallel to and between the up and down paths, and each car is attached to the same set of ropes or chains when traversing either path.

6. A lift system as claimed in any of claims 1 to 5, wherein transfer of a car from one path to another is effected by a vertical translation of the car, a horizontal translation of the car as for example by rotation about a vertical axis and a second vertical translation in the opposite direction to the first vertical translation.

7. A lift system as claimed in any of claims 1 to 6 wherein each car is equipped with two sets of moveable arms and has the same orientation whichever path it occupies.

8. A lift system as claimed in any of claims 1 to 7 wherein means are provided to transfer a car to a position outwith the vertical or horizontal path followed by the car in normal operation.

9. A lift system as claimed in any of claims 1 to 8, wherein means are provided to permit one car to be linked to another car in the same path whereby the two cars together can be caused to rise or fall using only the propulsion means associated with one of the cars.

10. A lift system as claimed in any of claims 1 to 9

wherein the propulsion means of a car comprises at least one rotatable wheel rotatably mounted on the car and adapted to engage a fixed vertical member in either path.

11. A lift system as claimed in claim 10, wherein drive is transmitted by way of frictional engagement of the propulsion wheel with the fixed vertical member.

12. A lift system as claimed in claim 11, wherein a rack is provided in addition to the fixed vertical member and this is engaged by a toothed gear wheel which provides positive braking when required.

13. A lift system as claimed in claim 12, wherein the flanks of the gear teeth normally support little, if any, of the weight of the car.

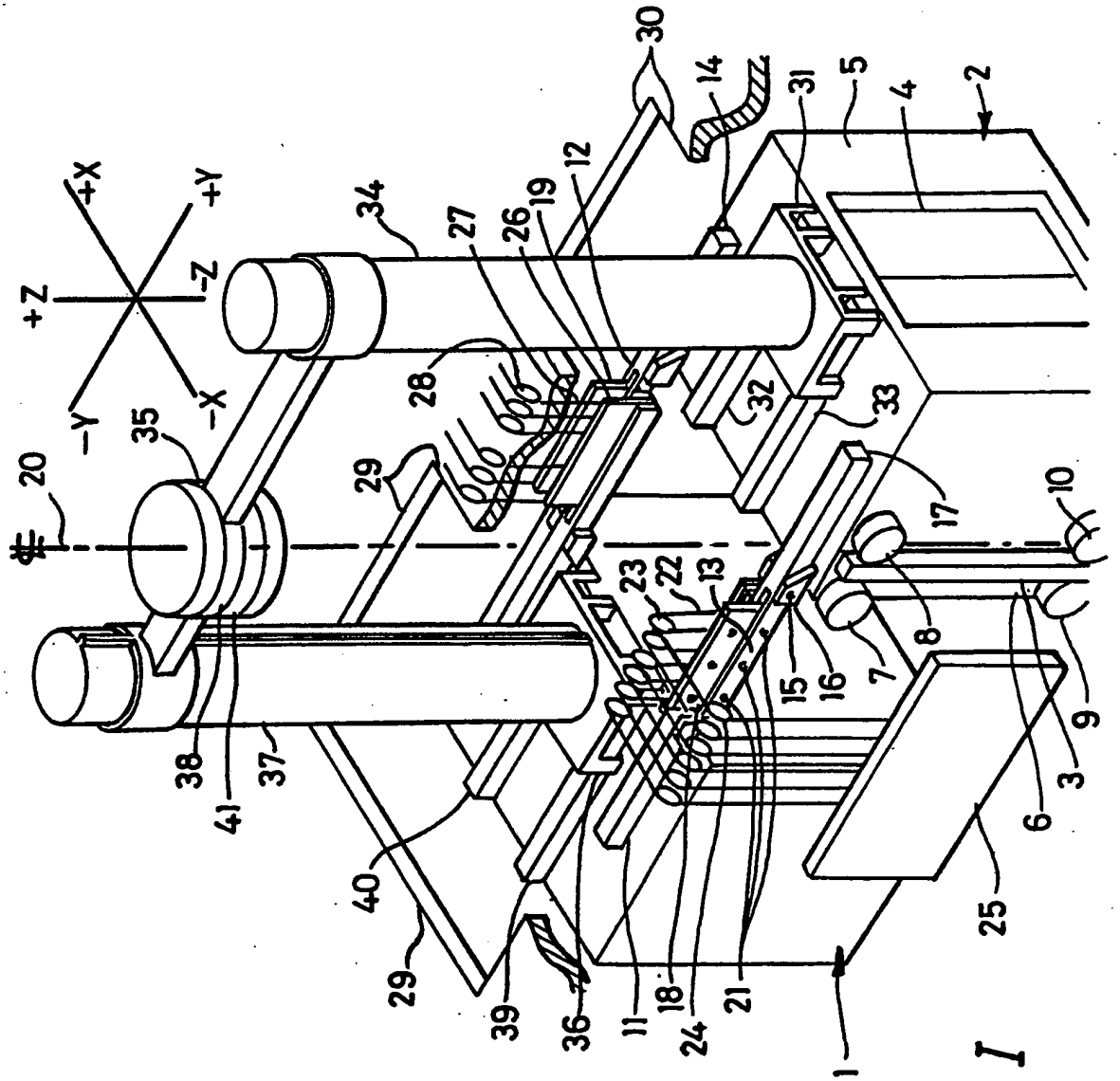
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Fig. 1

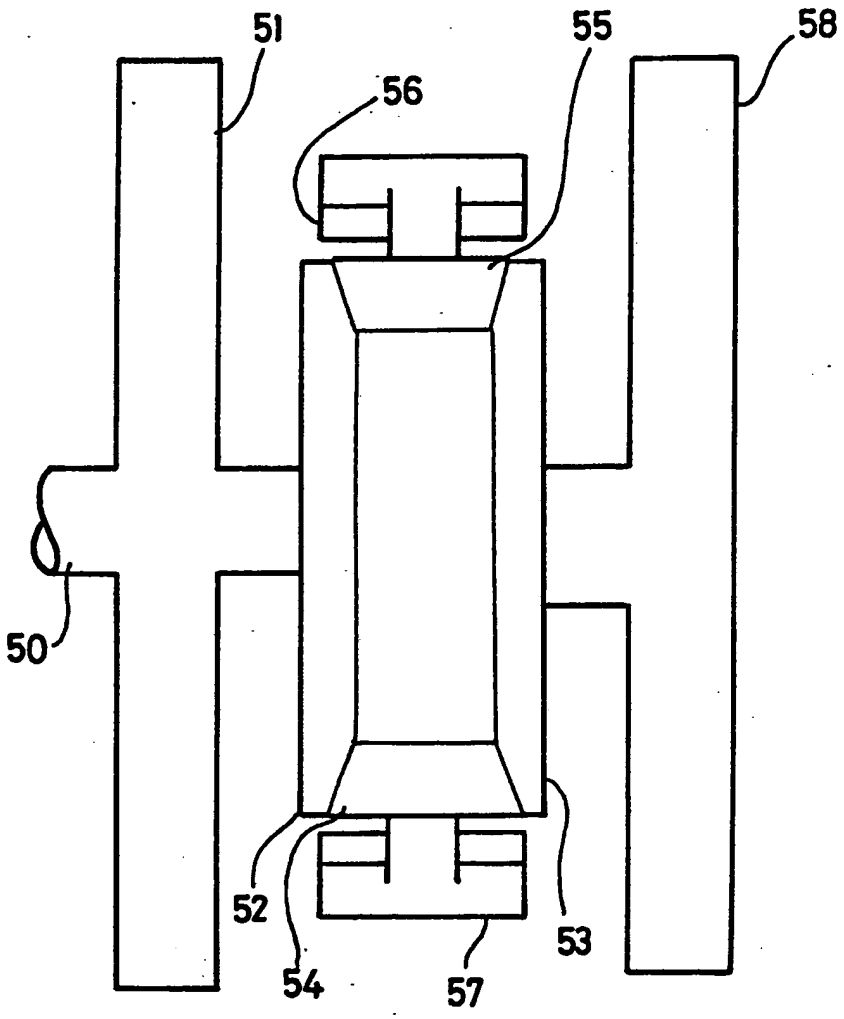

Fig II

INTERNATIONAL SEARCH REPORT

PCT/GB 90/01818

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B66B9/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B66B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	US,A,3658155 (SALTER) 25 April 1972 see column 3, line 40 - column 4, line 45; figures 1, 6, 7	1
A	---	2-13
A	GB,A,2169867 (HYDE) 23 July 1986 see page 3, lines 8 - 78; figures 3, 4	1-13

A	US,A,3317005 (KEHOE) 2 May 1967 see column 5, line 1 - column 6, line 55; figures 1, 4-11	1-13

A	US,A,2612238 (ANGELICOLA) 31 December 1949 see column 4, line 72 - column 5, line 19; figures 1, 2	1-13

A	US,A,1939729 (STARK) 19 December 1933 see page 2, lines 101 - 137; figures 11-13	1

° Special categories of cited documents :[10]

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
19 MARCH 1991	- 8. 04. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	CLEARY F.M. Fidelma Cleary

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9001818

SA 42058

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 19/03/91
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-3658155	25-04-72	None	
GB-A-2169867	23-07-86	None	
US-A-3317005		None	
US-A-2612238		None	
US-A-1939729		None	